Smart/Micro Grids Research Center
Department of Electrical Engineering
University of Kurdistan

Microgrids

(Spring 2024)

Instructors: Hassan Bevrani, and Qobad Shafiee

Course Description

Microgrid (MG) concept provides a quite appealing solution for overcoming the challenges of integrating renewable energy sources (RESs) and distributed energy resources (DERs) into the power grids. The MGs are small electrical distribution systems that interconnect multiple customers, DERs, and storage systems and are known as the main building blocks of the smart grids. This course provides both theoretical knowledge and practical foundation for understanding of MGs. The course describes the most important issues on individual MGs and interconnected MGs (IMGs) modeling, stability, and control as well as new relevant perspectives and research outcomes. The topics given in this course provides a thorough understanding of the basic principles, e.g. MG/IMG structures, types, operating modes, dynamics, and control levels. Several MG structure modeling, stability analysis methodologies, and fundamental and advanced control approaches are presented supported by simple examples and simulation/experimental results. Basic knowledge in *linear control systems* and *power electronics* are the requirements for taking this course.

Topics Covered

Introduction: Course Description, an Introduction on MGs (by H. Bevrani & Q. Shafiee)

Part I: By Q. Shafiee

1. MG Structure and Concept
2. Power Electronics for Renewable Energy Sources
3. Microgrid Dynamic Modeling
4. Microgrid Stability
5. Microgrid Control: Concepts and Fundamentals

Part II: By H. Bevrani

1. Grid Connected Converters: Modeling, Stability, and Control
2. Virtual Dynamics
3. Advances in MG Control
4. Interconnected MGs: Modeling, Stability and Control
5. Specific Topics in MGs

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Objectives

Successful completion of this course equips students with a solid understanding of MG fundamentals, relevant topics, and methodologies for analysis and synthesis. Through engaging in small projects, students get practical experience that helps them better understand the modeling, stability, and control techniques introduced in the course, preparing them for potential research contributions in the field of MGs. In summary, completing the course must give the following knowledge, skills and capabilities to the students who attend all lectures actively:

1. A deep knowledge on the preliminary concepts, frameworks, and components of an MG system.
2. Learning some methodologies for MG modeling, stability analysis, and control design.
3. Learning how to simulate an MG with a minimum requirement using MATLAB.
4. Ability to conduct new research in the relevant areas and complete it.
5. Making an enough strong background for self-learning of other topics and tools in MG field in a short time.

Grading

- Homework/Activities 20%
- Project Reports and Presentation 50%
- Final Exam 30%

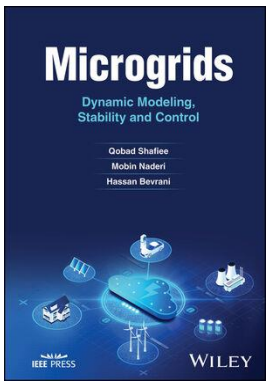
References

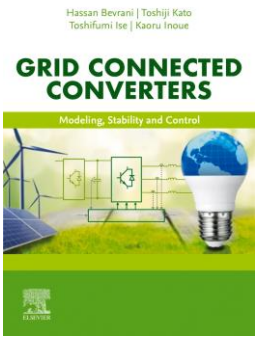
[1] Q. Shafiee, M. Naderi, H. Bevrani, *Microgrids: Dynamic Modeling, Stability and Control*, Wiley-IEEE Press, January 2024.

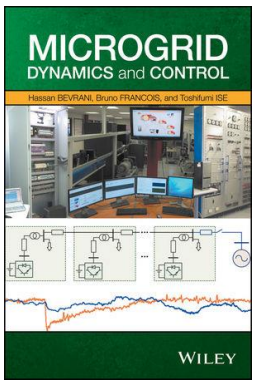
[2] H. Bevrani, B. Francois, T. Ise, *Microgrid Dynamics and Control*, Wiley, July 2017.

[3] H. Bevrani, T. Kato, T. Ise, K. Inoue, *Grid Connected Converters: Modeling, Stability and Control*, Academic Press (Elsevier), August 2022.

[4] H. Bevrani, and Q. Shafiee, *Microgrids Course Lecture Notes*, Spring 2024.







Course Notes

All course materials will be available online at the SMGRC website.

January 2024

Homework and Project Reports

The course homework/assignments will be performed along the semester. The project is organized to be performed on several steps during term-time and covers many topics of the courses. The report of each step (as a small project) should be submitted by the determined deadline during the semester. At the end, it may be required to present the project results (of all steps) in a meeting.

Policy

1. Even though discussion and study groups are encouraged, students who copy answers or procedures in homework assignments or who allow their answers or procedures to be copied will be considered to be cheating and corresponding penalties will be applied.
2. Late homework is not accepted unless extenuating circumstances are present.
3. Projects can be done individually or by teams of two or three. If the homework is done by a team, both students need to submit the report and source files individually, but the teamwork should be declared in the report.